SPATIAL TRIP PATTERN OF ROURKELA

A THESIS SUBMITTED IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

Bachelor of Technology
In
Civil Engineering

By
Manas Manchanda
And
Usharani Panda

Department of Civil Engineering
National Institute of Technology
Rourkela
2007

SPATIAL TRIP PATTERN OF ROURKELA

A THESIS SUBMITTED IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

Bachelor of Technology

In

Civil Engineering

By

Manas Manchanda

And

Usharani Panda

Under the Guidance of
Mrs S. Behera

Department of Civil Engineering
National Institute of Technology
Rourkela

2007

National Institute of Technology
Rourkela

CERTIFICATE

This is to certify that the thesis entitled, "SPATIAL TRIP PATTERN OF ROURKELA", submitted by Manas Manchanda (10301026) and Usharani Panda (10201015) in partial fulfillment of the requirements of the award of Bachelor of Technology Degree in Civil Engineering at the National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by them under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other university / institute for the award of any Degree or Diploma.

Date: 03.05.07

Mrs. S. Behera
Dept. of Civil Engg.
National Institute of Technology
Rourkela - 769008

Acknowledgment

We avail this opportunity to extend our hearty indebtedness to our guide **Mrs. S. Behera**, Civil Engineering Department, for her valuable guidance, constant encouragement and kind help at different stages for the execution of this dissertation work.

We also express our sincere gratitude to **Dr. K. C. Patra**, Head of the Department, Civil Engineering, for providing valuable departmental facilities.

Submitted by:

Manas Manchanda
Roll No: 10301026
Civil Engineering
National Institute of Technology
Rourkela

Usharani Panda
Roll No: 10201015
Civil Engineering
National Institute of Technology
Rourkela

CONTENTS

ABSTRACT

Urbanization has significant impact on urban activities and traffic and travel patterns in cities. Cities are experiencing processes of densification and spatial expansion. With rise in urban activities, trip rates have moved upwards and transport demand is rising significantly, poor public and transportation not only have throttled the movement but also have pushed up personalized travel through private vehicles.

Transport impact due to rapid urbanization in Rourkela has been taken up to highlight the spatial scenarios of trip rates and their other concerned attitudes so as to provide proper input for better transport planning.

Spatial trip rate pattern is a model to explain, understand and predict the level of interaction between different geographic locations

Transportation in cities plays a vital role in providing necessary access and mobility to urbanites. It has become uneconomical and environmental issue if it is not balanced in terms of different systems. If mass public transport system is not developed matching the pace of city growth, personalized vehicle movement will increase leading to traffic congestion and pollution.

Analysis in this paper reflects trip rates. Trip rate characteristics and mode usage, in the urban domain. Purpose and mode based trip rates are quite useful in framing strategies for urban transportation in an effective way

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Transportation in metropolitan areas plays a vital role in providing necessary access and mobility to urbanites. However, it becomes uneconomical and environmental issue if it is not balanced in terms different systems. Proper blend of public, private and personal vehicles in transport system is need of the hour to meet the objectives. If mass public transport system is not developed matching with the pace of metropolitan growth, shift towards personalized vehicle movement will be forced upon people leading to the traffic congestion and population.

The first stage in the formulation of a transportation plan is to collect data on all factors that are likely to influence travel pattern. The work involves a number of surveys so as to have an inventory of existing travel pattern, an inventory of existing travel facilities and an inventory of existing land use and economic activities. This stage of planning process entails voluminous work and may take as much as 2 years for completion.

1.2 Defining of study area:

The study area for which the transportation facilities are being planned is first of all defined. Transportation planning can be at the national level, regional level or the urban level. For planning at urban level, the study area should embrace the whole conurbation containing the existing and potential continuously built-up areas of the city.

The imaginary line representing the boundary of the study area is termed as the ‘external cordon’. The area inside the external cordon line determines the travel pattern to a large extent and as such surveyed in great detail. The land-use pattern and the economic activities are studied intensively and detailed surveys (such as the home interview) are conducted in these areas to determine travel characteristics. On the other hand, the area outside the external cordon line is studied to a lesser degree of detail.

The selection of external cordon line for an urban transportation study should be done carefully with due weightage to following factors:

The external cordon line should circumscribe all areas which are already built-up and those areas which are considered likely to be developed during the period of study.

The external cordon line should contain all areas of systematic daily life of people oriented towards the city centre and should in effect be the ‘commuter shed’.

The external cordon line should be continuous and uniform in its course so that movements cross it only once. The line should intersect the roads where it is safe and convenient to carry out traffic surveys.

The external cordon line should be compatible with previous studies of the area of studies planned for the future.

CHAPTER 2

ZONING

2.1 Zoning:

The defined study area is sub-divided into smaller areas called zones.

The purpose of such a sub-division is to facilitate the spatial quantification of land-use and economic factors which influence travel pattern. The data collected on individual household basis cannot be conveniently considered and analyzed unless they are aggregated into smaller zones which reflect the average characteristics of individual households. Sub-division into zones further helps in geographically associating the origins and destinations of travel. Zones within the study area are called internal zones and those outside the study area are called external zones. In large study projects, it is ore convenient to divide the study area into sectors, which are sub-divided into smaller zones. Zones can themselves be sub-divided into sub-zones depending upon land-use.

A convenient system of coding of the zones will be useful for the study. One such system of coding is to divide the study area into 9 sectors. The central sectors (CBD) is designated as 0, the remaining 8 are designated as 1 to 8 in clock-wise manner. The prefix 9 is reserved for the external zones. Each sector is sub-divided into 10 zones bearing numbers 0-9. Thus a system of three digits denotes a sub-zone. A sub-zone bearing numbers 481 belongs to Sector 4 and to Zones 8 in that sector and is sub-zone 1 in that zone.

It would be helpful if the following points are kept in view when dividing the area into zones:

1. Land-use is the most important factor in establishing zones for a transportation survey. It is only when the origin and destination zones reflect properly the land-use can traffic generated within the zones be predicted, measured and qualified accurately. The predominant land-use for establishing zone are: residential, industrial, commercial, recreational, open space, shopping, etc.
2. The zones should have a homogenous land-use so as to reflect the associated trip-making behavior.
3. Anticipated changes in land-use should be considered when sub-divided the study area into zones.
4. It would be advantageous if the sub division follows closely that adopted by other bodies for data collection. This will facilitate correlation of data. Specially useful in this respect in the sub division adopted for census operations, since the census is a very useful source of much data needed for transportation planning.
5. The zones should not be too large to cause considerable errors in data. At the same time, they should not be too small either, to cause difficulty in handling and analyzing the data. As a general guide, population of 1000-3000 may be optimum for a small area and a

population of 5000-10000 is optimum for a large area. In residential areas the zones should accommodate roughly 1000 house-holds.

6. The zones should preferably have regular geometric form for easily determining the centroid which represents the origin and termination of travel.
7. Sectors should represent the catchment of trips generated on a primary route.
8. Zones must be compatible with screen lines and cordon lines.
9. Zone boundaries should preferably be water-sheds of trip-making.
10. Natural or physical barriers such as canals, rivers etc. can form convenient zone boundaries.

In addition to external cordon lines, there may be a number of internal cordon lines arranged as concentric rings to check the accuracy of survey data. Screen lines running through the study area are also established to check the accuracy of data collected from home interview surveys. Screen lines can be conveniently located along physical or natural barriers having few crossing points. Examples of such barriers are rivers, railway lines, canals, etc.

CHAPTER 3

TYPES OF SURVEY

3.1 Types of Survey:

The basic movements for which survey data are required are:

1. Internal to internal
2. Internal to external
3. External to internal
4. External to external

For large urban areas, the internal to internal travel is heavy whereas for small areas having a small population (say less than 5000) the internal to internal travel is insignificant. The internal to internal travel is best studied by home interview technique with checks by screen line surveys. The internal to external, external to internal and external to external travels can be studied by cordon surveys. The internal to external travels can also be surveyed by home interview technique.

The surveys can collect data

1. At home
2. During the trip and
3. At the destination ends of the trip.

When collected at the home, the data can be wide ranging and can cover all the trips made during a given period. The data collected during the trip is necessarily of limited scope since the procedure yields data only on the particular trip intercepted. At the destination ends, the direct interview types of surveys provide data on demand for parking facilities and on major traffic attractors such as factories, offices and commercial establishments.

The following are some of the surveys that are usually carried out:

1. home interview surveys
2. commercial vehicle surveys
3. taxi surveys
4. road-side interview surveys
5. post card questionnaire surveys
6. registration number surveys
7. tag surveys
8. public transport surveys

3.2 Home Interview survey:

Home interview survey is one which is most reliable type of survey for collection of origin and destination data. The survey is essentially intended to yield data on the travel pattern of the residents of the households and general characteristics of the household influencing trip making. The information on travel pattern includes the number if trips made, their origin and destination, purpose of the trip, their travel mode, their origin and destination, and so on. The information includes the dwelling unit, number of residents, age, sex, race, vehicle ownership, number of drivers, family income and so on. Based on these data it is possible to relate the amount of travel to household and zonal characteristics and develop equations for trip generation rates.

Because of the widely variety of data that can be collected by the home-interview and the high cost involved, it is necessary to standardize the procedure for surveys. One such well-known procedure is contained in Bureau of Public Roads Manual which precisely describes how the interview is to be conducted and hat information is to be collected.

It is impractical and unnecessary to interview all the residence of the study area. Since travel patterns tend to be uniform in a particular zone, it is insufficient if a sampling procedure is employed. The size of the sample is usually determined on the basis of the population of the study area and the standards given in table of Bureau of Public Roads are often used.

A number of techniques are available for home interview survey. The home interview technique involves interviewing as many members of the household as possible and directly recording all the information. In the home questionnaire technique, the interviewer collects only the details of the household characteristics, leaving forms for household residents to complete in regard to travel information. The completed forms are collected by the interviewer after a day or two.

In both the above methods, it is necessary to send out a letter to selected household prior to the proposed interview, explaining the nature, importance and objectives of the survey and eliciting their co-operation.

Usually the full interview technique is more expensive, and it may be possible to collect the needed information only at the rate of eight interviews per eight hour per day per interviewer. The home questionnaire technique is speedier and it may be possible to cover 20 households per day. While the full interview technique yields very accurate data, the same cannot be said of home questionnaire method.

Variations of the above techniques sometimes used in the past are telephone interview and postal survey. In the former the questionnaire is sent out by post before the survey data and the replies are elicited by the telephone. This method can be successful only in areas of high telephone ownership. In the postal survey method the questionnaire is mailed and the households are requested to send their replies by post in reply-paid envelopes. It may often be found that response to postal survey technique will be a low level inspite of wide prior publicity.

The information to be collected from the home interview survey can be broadly classified under two groups: household information and journey data. The household information contains information such as address, size of household, age, sex, structure of household, earning members, occupation, place of work, the number of motor vehicles, household income and so on. The journey data contains all journeys made during 24hour period, including the origin and destination of the journey, purpose of the trip, mode of travel etc… the survey forms are generally standardized for this purpose and the questionnaire are structured carefully to avoid ambiguity. The usual practice is to have household information in the front of the form and the trip information on the back of the form. The form should be so designed that the data can easily be coded.

CHAPTER 4

TRIP GENERATION

4.1 TRIP PURPOSE:

Trips are made for different purposes and a classification of trips by purpose is necessary. The following are some important classification of trip purpose:

Work

School

Business

Social or recreational, sports

Others

The break-ups of the trips by purpose is normally done for the home-based trips which represents nearly 80-90% of total trips.

4.2 FACTORS GOVERNING TRIP GENERATION AND ATTRACTION RATES:

A number of factors govern trip generation rates. These are discussed below:

(1) INCOME: obviously, family income with represents its ability to pay for a journey affects the number of trips generated by a household. A general trend id that the higher the income the higher is trip generated rate.

(2) CAR OWNERSHIP: a car represents easy mobility, and hence a car owning household will generate more trips than a non-car-owning household. By the same reasoning, the more cars there are in a household, the more the number of trips generated. Of –course, number of cars owned is itself related to the income of the family, which has been listed earlier as a factor.

(3)FAMILY SIZE AND COMPOSITION: the bigger the family, the more trips there are likely to be generated. Apart from the size, the composition of the family itself is important. For instance, if both husband and wife are employed, the trips generated will be more than when only husband is employed. If there are as many school going children, the number of school-purpose trips will be large. If some of the children are grown up and are employed, the number of work trips will increase. The age structure of the family also

governs the trip rates. Old persons are not expected to generate as many trips as younger ones. The occupation of the family is also known to influence the travel patters.

(1) LAND USE CHARACTERISTICS: different land uses produce different trip rates. For example, a residential area with a high density of dwellings can produce more trips than one with a low density of dwellings. On the other hand, low density areas may represent dwellings of affluent society, which may produce a large number of private car trips. The rateable of the dwelling and the type of dwelling units affect the trip generation rates. The most important mode in transportation planning is that the amount of travel is dependent on land use.

(2) DISTANCE OF THE ZONE FROM TOWN CENTRE: the distance of the zone from the town centre is an important determinant of the amount of travel that people might make to the town centre. The farther the town centre, the less the number of trips are likely to be.

(3) ACCESSIBILTY TO PUBLIC TRANSPORT SYSTEM AND ITS EFFICIENCY: The accessibility to a public transport system and its efficiency determine to some extent the desire of person to make trips. An easily accessible and efficient public transport system generates more trips.

(4) Employment opportunities, floor space in the industrial and shopping units and offices, sales figure in shops etc… the employment potentially of an industrial or shopping unit or an office establishment directly governs the trip attraction rate. Similarly, another factor to which trip attraction rate can be related is the floor space in the premises of industries, shops and offices.

CHAPTER 5

ANALYSIS

5.1 ANALYSIS:

Division of zones:

ZONE 1	JAGDA, JHIRPANI, KOEL NAGAR
ZONE 2	Sec 1 (A, B, C), Sec 2 (A, B, C, D)
ZONE3	Sec 1 (F, G, H), Sec 2 (g, h), Sec 3, Sec 4
ZONE 4	Sec 20, Sec19 (A, B, C, D, E, F)
ZONE 5	Sec 5, STPI Area, Sec 6, Sec 7, Sec 8, Sec9
ZONE 6	Sec 18, Sec 19G, Sec 13, Sec 14, Sec 15, Sec 16, Sec 17

Table 5.1

Rourkela, the largest city in Orissa, is growing at a rapid pace. It is a fast developing industrial city. Rourkela Steel Plant is the main industry out here.

The city is divided into a number of zones for the ease of collection and arrangement of data for the analysis. The division is shown in the table given above (table 5.1).

Survey is done by home interview technique. A questionnaire containing Name, Address, House number, No. of Adults, No. of minors, Total number of earning members, Occupation, Gross income, Total family income, Total no. of weekly trips to:- Work, Education, Shopping, Social, Recreation, Others, Mode of trip:- Bicycle, 2wheeler, 4wheeler, Auto, Bus, By walk is being distributed in a number of houses in each zone.

A sample of the questionnaire is shown below.

NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA-8

DEPARTMENT OF CIVIL ENGINEERING (B Tech. Project)

Study of Spatial Trip Pattern of Rourkela Urban Area

Household Survey Questionnaire

Zone Number	Name	Address	House Type/Area	Govt. Qr. / Owned /Rented

No. of Adults		No. of Minors		Total Number of Earning Members		Occupation/ Nature of Job	Designation	Gross Total Income
M		M		M				
F		F		F				
Total Family Income								

No. of Vehicles	Bicycle	2 wheeler	4 wheeler			

Total Number of Weekly Trips To		Work	Education	Shopping	Social	Recreation	Others
Destination							
Mode of Trip	3 wheeler / Auto						
	Bus						
	Bicycle						
	2 wheeler						
	Car						
	By Walk						

Mr. Manas Manchanda (10301026)
Ms. Usharani Panda (10201015)

Project Guide:
Prof.(Mrs.)S. Behera

5.2 HOUSEHOLD'S SOCIO ECONOMIC BASE

5.2.1 HOUSEHOLD CHARACTERS

Main parameters affecting travel pattern are urban household characters, income and vehicle ownership sector wise household characteristics are given in table 5.2. Average household size, number of household adults and children in a city are 4.503, 3.21, and 1.304 respectively, whereas as working members are 1.378 per household. Zone 3, which is growing fast and belong to educated and high income classes. Family size analysis shows that nearly 66% households have family size of 4-5 and 21% families have size less than 4 and 12% of families have size more than 5.

Sector	Total No. Of Family Members	Adults	Children	Working Members	School Going Members
Zone 1	4.3	3.02	1.28	1.32	1.15
Zone 2	5.18	4.06	1.125	1.68	1.025
Zone 3	4.66	3	1.66	1.33	1.58
Zone 4	3.74	2.33	1.41	1.48	1.39
Zone 5	4.46	3.2	1.13	1.13	1.11
Zone 6	4.48	3.66	1.22	1.33	1.21
AVERAGE	4.503	3.21	1.304	1.378	1.245

Table 5.2

5.2.2 INCOME STRUCTURE

Monthly income observed in the survey varies from 1500 to 80000 for a household depending upon the nature of the job and number of earning members. Table 5.3 provides zone wise income structure. Table shows that zone 3 is the highest income zone i.e. 30.5.

Sector	Average (in 1000 rs / month)
Zone 1	16.22
Zone 2	18.406
Zone 3	30.5
Zone 4	22.97
Zone5	19.83
Zone 6	21.38

Table 5.3

5.2.3 VEHICLE OWNERSHIP PATTERN

Vehicle ownership for various modes such as bicycles, two wheelers, and cars are shown in table 5.4. Car and 2 wheeler ownership is significantly varying in all zones. Affluent zone is zone 3 where vehicle ownership is 3.93. Zone 4 has least number of vehicle ownership i.e. 2.32

Sector	Bicycle/ H.H	2W / H.H	4W / H.H
Zone 1	1.2	1.22	.36
Zone 2	1.5	1.625	.3125
Zone 3	1.8	1.3	.83
Zone 4	.64	1.25	.43
Zone 5	1.86	1.53	.2
Zone 6	1.88	1.11	.11
average	1.48	1.084	.37

Table 5.4

.

5.2.4 PURPOSE WISE WEEKLY TRIPS PER HOUSEHOLD

Trip purpose is one of the most important analytical parameters. Total trips per week for a household are 15 to 30 and the average value is 23.32 trips. Average weekly trip for different purposes for the study zones are shown in table 5.5. Percent trip purpose wise for each zone is given in table 5.6. This is shown by a pie chat given in figure 1. Work based trips are 29.34%, whereas trips for education purposes are 33.20%.

Table 5.5

Sector	Average weekly trips / H.H						Total
	Work	Education	Shopping	Social	Recreation	Others	
Zone 1	7.26	7.52	3.72	2.68	2.84	1.86	25.88
Zone 2	6.06	4.44	2.75	1.56	1.19	0.875	16.875
Zone 3	7.5	4.33	2.33	2.5	1.17	1.83	19.66
Zone 4	8.77	6.87	4.67	2.21	2.18	1.53	26.23
Zone 5	6.13	9.13	3	2.067	1	1.2	22.527
Zone 6	8.44	9.55	4.11	2.55	0.67	3.44	28.76
Average	7.36	6.97	3.43	2.26	1.508	1.79	23.32

Table 5.6

Sector	Purpose Wise Trips (%)						Total
	Work	Education	Shopping	Social	Recreation	Others	
Zone 1	28.05	29.05	14.48	10.35	10.97	7.18	100
Zone 2	35.91	26.31	16.29	9.25	7.05	5.18	100
Zone 3	38.14	22.02	11.85	12.71	5.95	9.3	100
Zone 4	33.44	26.19	17.80	.084	8.3	5.83	100
Zone 5	27.21	40.52	13.31	9.17	4.43	5.32	100
Zone 6	29.34	33.20	14.29	8.86	2.32	11.96	100

5.2.5 MODE BASED TRIP RATES

Modal split analysis of surveyed data highlights the dominance of usage of 2 wheelers. Table 5.7 and 5.8 provide details in this regard. Bicycle usage is more in zone2. Higher modal value of cars has been found in affluent sectors like zone 3.It is nearly 35.3%. Because of poor city

bus services on one hand and promotion of 2 wheelers through different financing schemes in recent time, there is heavy shift towards 2 wheelers in the city.

Sector	Mode Wise Average Weekly Trips / H.H					Total
	Bicycle	2 Wheeler	4 Wheeler	Auto	Walk	
Zone 1	5.46	15.32	3.66	5.66	1.68	31.78
Zone 2	3.44	9.375	1.1	1.5	1.44	16.85
Zone 3	2.67	9.33	7	0.5	0.33	19.83
Zone 4	4.28	13.02	4	3.8	1.03	26.13
Zone 5	4.93	10.93	1.7	4.3	0.67	22.53
Zone 6	4	16	1	5	2.78	28.78
Average	4.13	12.33	3.07	3.46	1.32	24.32

Table 5.7

Sector	Mode Wise Average Weekly Trips / H.H (%)					Total
	Bicycle	2 Wheeler	4 Wheeler	Auto	Walk	
Zone 1	17.1	48.20	11.51	17.8	5.28	100
Zone 2	20.41	55.6	6.52	8.90	8.54	100
Zone 3	13.46	47.04	35.30	2.52	1.7	100
Zone 4	16.37	49.8	15.30	14.54	3.94	100
Zone 5	3.94	48.51	7.54	19.08	2.97	100
Zone 6	13.89	5.55	3.74	17.37	9.65	100
Average	14.195	42.45	13.32	13.36	5.34	100

Table 5.8

CHAPTER 6

RESULTS

RESULTS:

6.1. BAR GRAPH REPRESENTING ZONE-WISE HOUSE-HOLD CHARACTERS

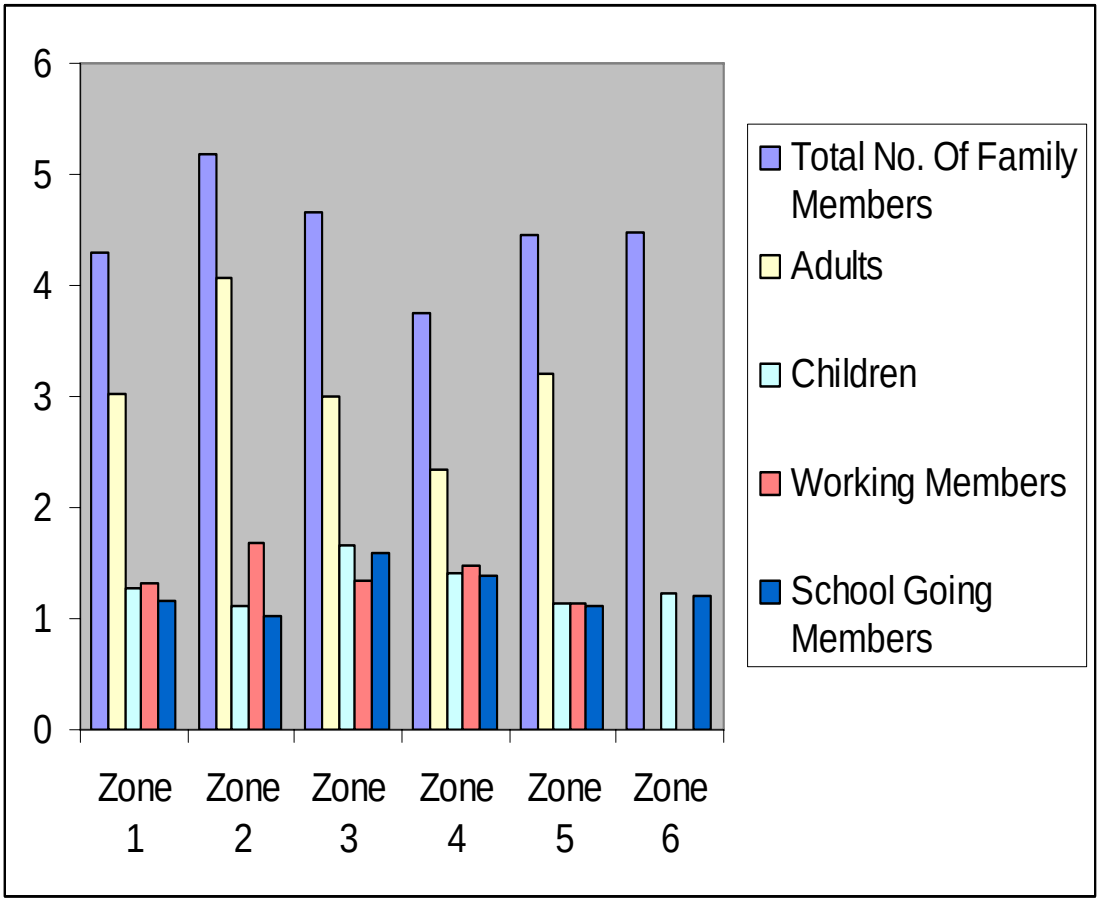

FIGURE 6.1

6.2 BAR GRAPH REPRESENTING INCOME STRUCTURE:

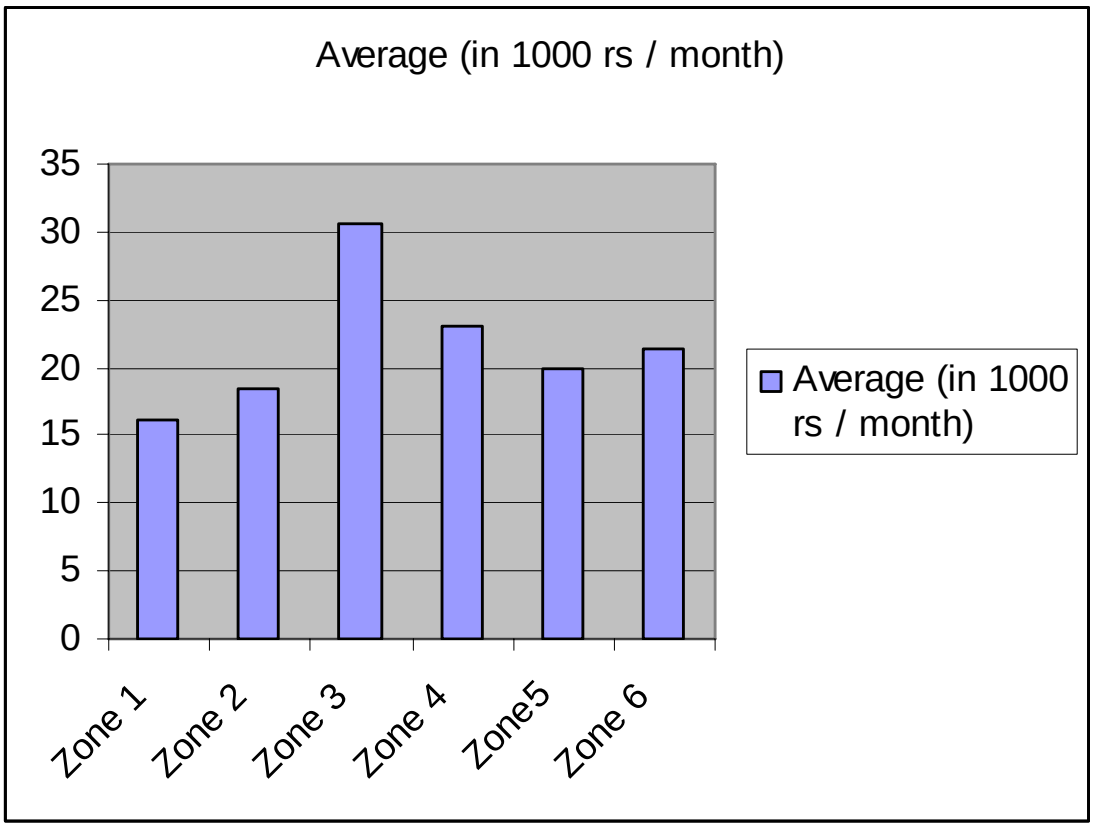

FIGURE 6.2

6.3 BAR GRAPH REPRESENTING VEHICLE OWNERSHIP PATTERN

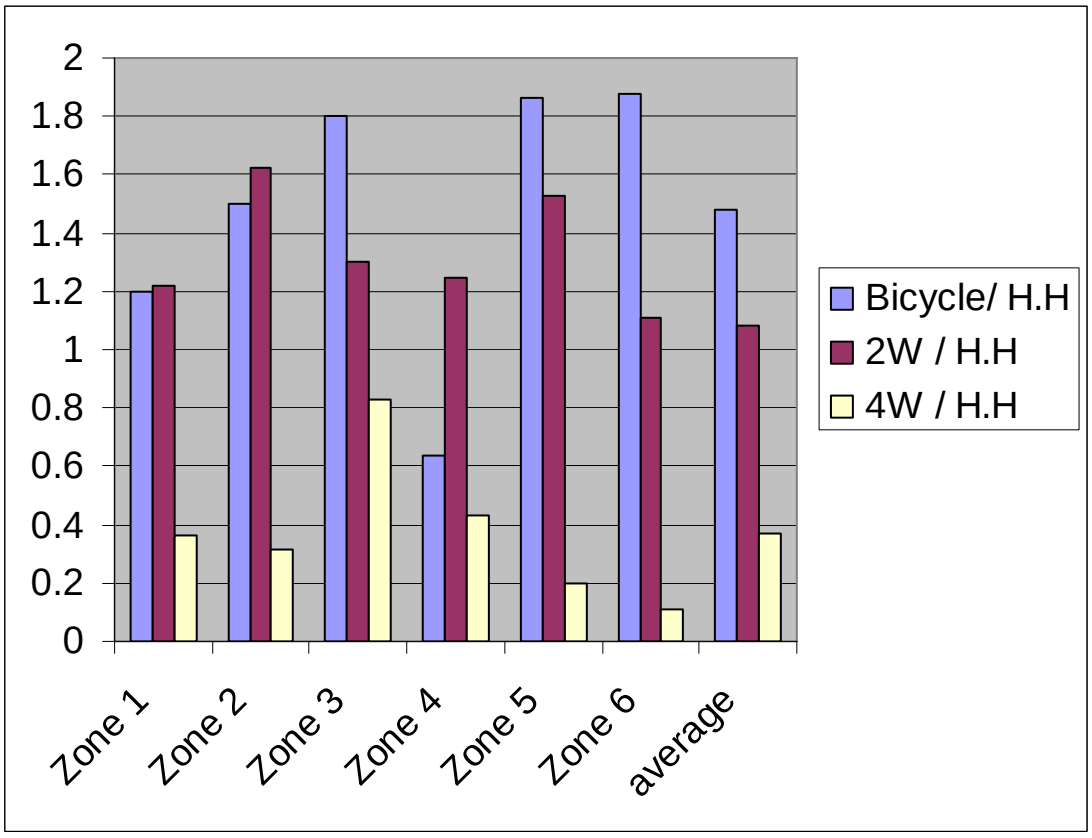

FIGURE 6.3

6.4 BAR GRAPH REPRESENTING PURPOSE-WISE WEEKLY TRIPS PER HOUSEHOLD

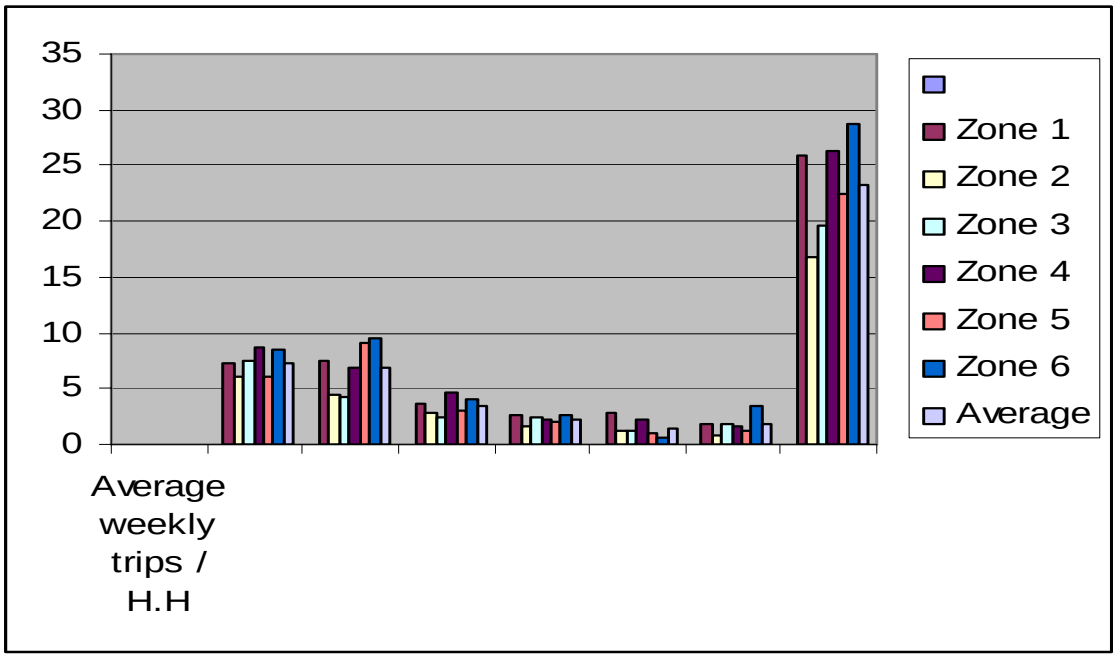

FIGURE 6.4

PIE CHART SHOWING THE AVRAGE PURPOSE-WISE TRIP RATE

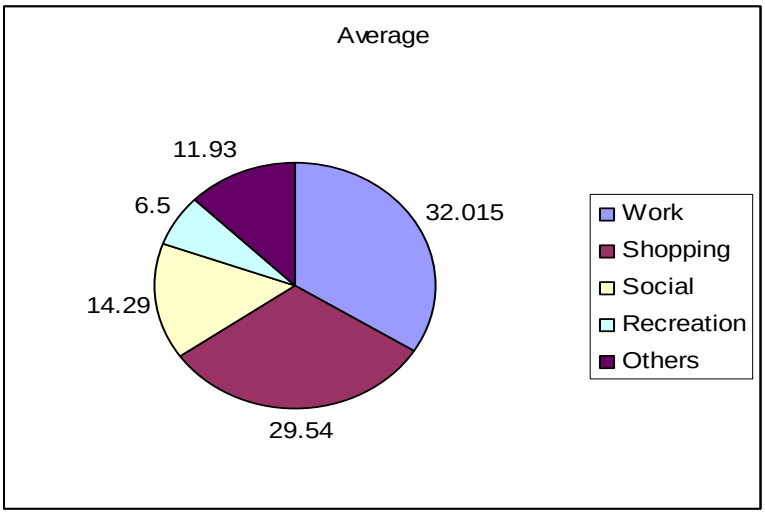

FIGURE 6.5

6.5 BAR GRAPH REPRESENTING MODE-WISE WEEKLY TRIPS PER HOUSEHOLD

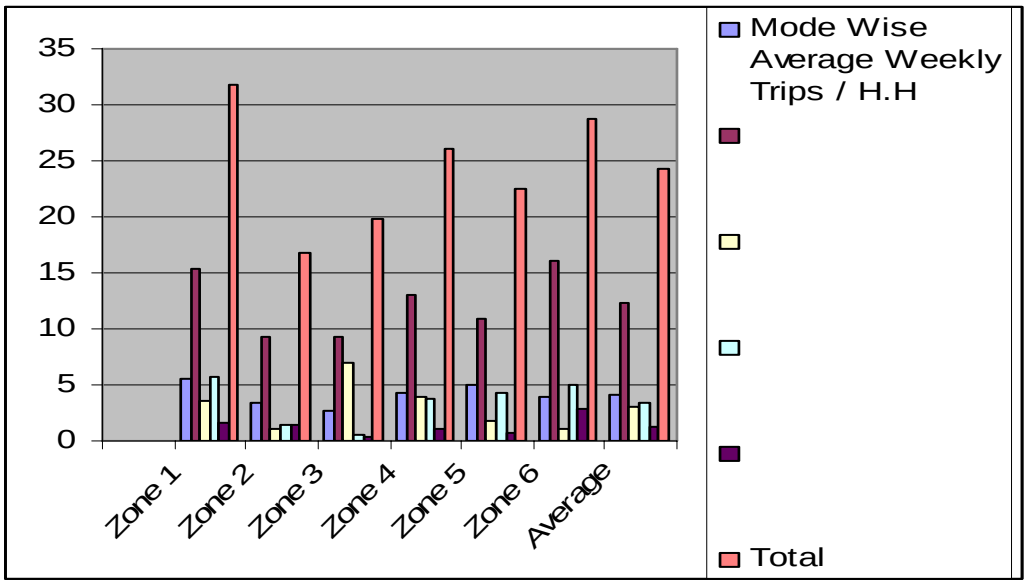

FIGURE 6.6

PIE CHART SHOWING THE AVRAGE MODE-WISE TRIP RATE

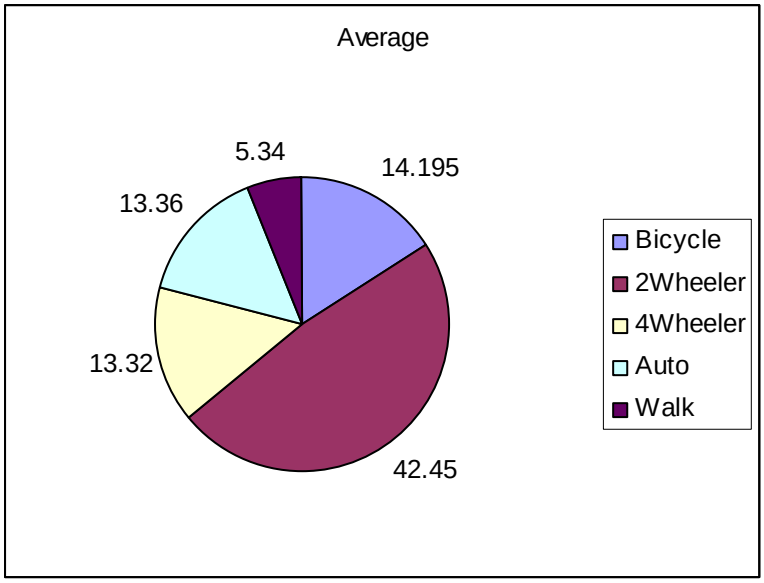

FIGURE 6.7

REFERRENCES

1. Kadiyali, L.R., Traffic Engg. And Transport Planning, Delhi: Khanna publishers, 2006
2. Joshi, G.J." Spatial Trip Rate Patterns." ITPI journal.2:1(2005): p.28-33
3. Agrawal, M.K."Urban Transportation." Journal of Indian highways, (1996)
4. Shridharan, E. "Urbanization and Urban Transport." Journal of Urban Transport, Vol.,No.1,March 2000